

COST AND PERFORMANCE REPORT

Land Treatment of UST Soil Stockpiles, Ft. Greely, Alaska

October 1998



Prepared by:
U.S. Army Corps of Engineers
Hazardous, Toxic, Radioactive Waste
Center of Expertise

SITE INFORMATION



IDENTIFYING INFORMATION

Site Name: UST Soil Stockpiles
Location: Ft. Greely, Alaska
Technology: Land Treatment
Type of Action: Remedial Action

TECHNOLOGY APPLICATION

Period of Operation: September 1994 - August 1997 (1,2)

Quantity of Material Treated During Application: 9,800 cubic yards (yd³)

BACKGROUND

Site Background (1,2):

- The UST soil stockpiles are located at the 1970s landfill or "Landfill 7," located in the southeast sector of the U.S. Army Ft. Greely military facility. Ft. Greely is located approximately five miles south of Delta Junction, Alaska.
- The Black Rapids stockpile (BRS) of soil contaminated with diesel fuel was generated during upgrading of the facility and site restoration activities conducted at the Black Rapids Ski Area during the summers of 1992 and 1993.
- The small and large stockpiles of gasoline-contaminated soil (SGS and LGS) originated from the excavation of contaminated areas near buildings 602 and 606 at Ft. Greely in August 1991.

Waste Management Practices That Contributed to Contamination: Leaks from underground storage tanks (USTs) or overfilling of USTs or aboveground storage tanks (ASTs) (2)

Site Investigation (5):

- The diesel-contaminated soil in the Black Rapids area was identified during preconstruction sampling conducted in 1991 and in samples taken during construction excavation in 1992 and 1993. A report on the contractor's findings was submitted to the U.S. Army Corps of Engineers-Alaska District (USACE) in the summer of 1994.
- The extent of soil contamination in the area of buildings 602 and 606 at Ft. Greely was delineated and the contaminated soil excavated during a UST removal conducted in 1991 and 1992. The excavated soil was sampled between June 21 and 25, 1993 and the soil was determined to contain gasoline. Closure sampling for the excavations in the area of buildings 602 and 606 was conducted in May and June 1993.
- Soils excavated from the Black Rapids site were transported to Ft. Greely for treatment. Those soils were stockpiled and treated as part of the technology application discussed in this report.



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SITE LOGISTICS/CONTACTS

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MATRIX AND CONTAMINANT DESCRIPTION

MATRIX IDENTIFICATION

Soil (ex situ)

SITE STRATIGRAPHY (1)

- The subsurface consists of the capped 1970s Landfill, with groundwater at approximately 280 ft below ground surface.



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CONTAMINANT CHARACTERIZATION

Semivolatile and volatile nonhalogenated hydrocarbons - gasoline and diesel fuel

CONTAMINANT PROPERTIES

Property	Gasoline	Diesel Fuel
Chemical Makeup	Paraffins, olefins, naphthenes, and aromatics	Unbranched paraffins
Flash Point	less than 50° F	110° to 190° F
Toxicity	High	High

MATRIX CHARACTERISTICS AFFECTING TREATMENT COST OR PERFORMANCE (1)

Parameter	Soil to Be Treated
Soil classification	Poorly graded sandy gravel with silt (GP-GM) and poorly graded gravel with sand (GP)
Particle Size Distribution	GP-GM (69% sand, 19% silt, 12% clay), GP(53.3% gravel, 40.9% sand, 5.8% fines)
Organic Matter	1.3% - 1.4%
Moisture Content	7.7 - 13.2% (solid dry weight)
pH	7.3 (average)
Ammonia - Nitrogen	2.1 - 5.46 milligrams per kilogram (mg/kg)
Nitrate - Nitrogen	2 - 13 mg/kg
Available Nitrogen	9.3 mg/kg (mean)
Available Phosphorus	6.4 mg/kg (mean)
Available Potassium	23 mg/kg (mean)
Cation Exchange Capacity	4.7 milliequivalents per 100 grams (mean)
Biological Oxygen Demand (BOD) (two-days at 20° C)	34.8 mg O ₂ /kg soil ¹
Field Capacity	15 - 16% moisture

¹ BOD was calculated on the basis of reported hydrocarbon degradation rate results. Those results were based on the two-day differential in pore space oxygen from a closed sample incubated at 20°C. The two-day BOD value included contributions from degradation of non-contaminant organic material, as well as the degradation of the contaminant.



TREATMENT SYSTEM DESCRIPTION

PRIMARY TREATMENT TYPE

Land treatment

SUPPLEMENTARY TREATMENT TECHNOLOGY TYPE

Screening (pretreatment)

TIMELINE (1,2)

Date	Activity
August 1991	Gasoline-contaminated soil from excavations near buildings 602 and 606 at Ft. Greely stockpiled at the Landfill 7 site
1992 to 1993	Diesel-contaminated soil from excavations at Black Rapids Ski Area stockpiled at the Landfill 7 site
September to October 1994	Phase I - Screening and washing of stockpiles and biotreatability study
July to September 1995	Completion of Phase I work; first season of Phase II work, land treatment of soil
June 1996 to August 1996	Second season of Phase II work
June 1997	Performance of closure sampling.
May 1998	Submittal of remedial action report (RAR)

TREATMENT SYSTEM (1,2,5)

- This application was conducted in two phases: Phase I, pretreatment of the stockpiled soil, and Phase II, land treatment of the contaminated soil.

Phase I - Screening and Washing of the Stockpiles

- Figure 1 shows the layout for the soil screening and washing equipment used in Phase I of this remediation effort.
- The soils from the site were screened and sorted into stockpiles by particle size (<1", 1" - 5", >5") and contaminant type—diesel and gasoline.
- According to the RAR, the stockpiles containing material of a diameter greater than 5" had no odor or visible contamination and were considered clean. Those stockpiles were not treated.
- For this project, ADEC extended the policy on oversized material to include all materials of a diameter greater than one inch that were free of odor or visible contamination. Therefore, the soils containing materials of a diameter of 1 inch to 5 inches were not treated. Those soils were spray- washed with a mixture of PES-31 (a proprietary additive containing a suspension of live cultured microorganisms preserved in a sterile solution with no nutrients) and water and left on site for use as final cover.



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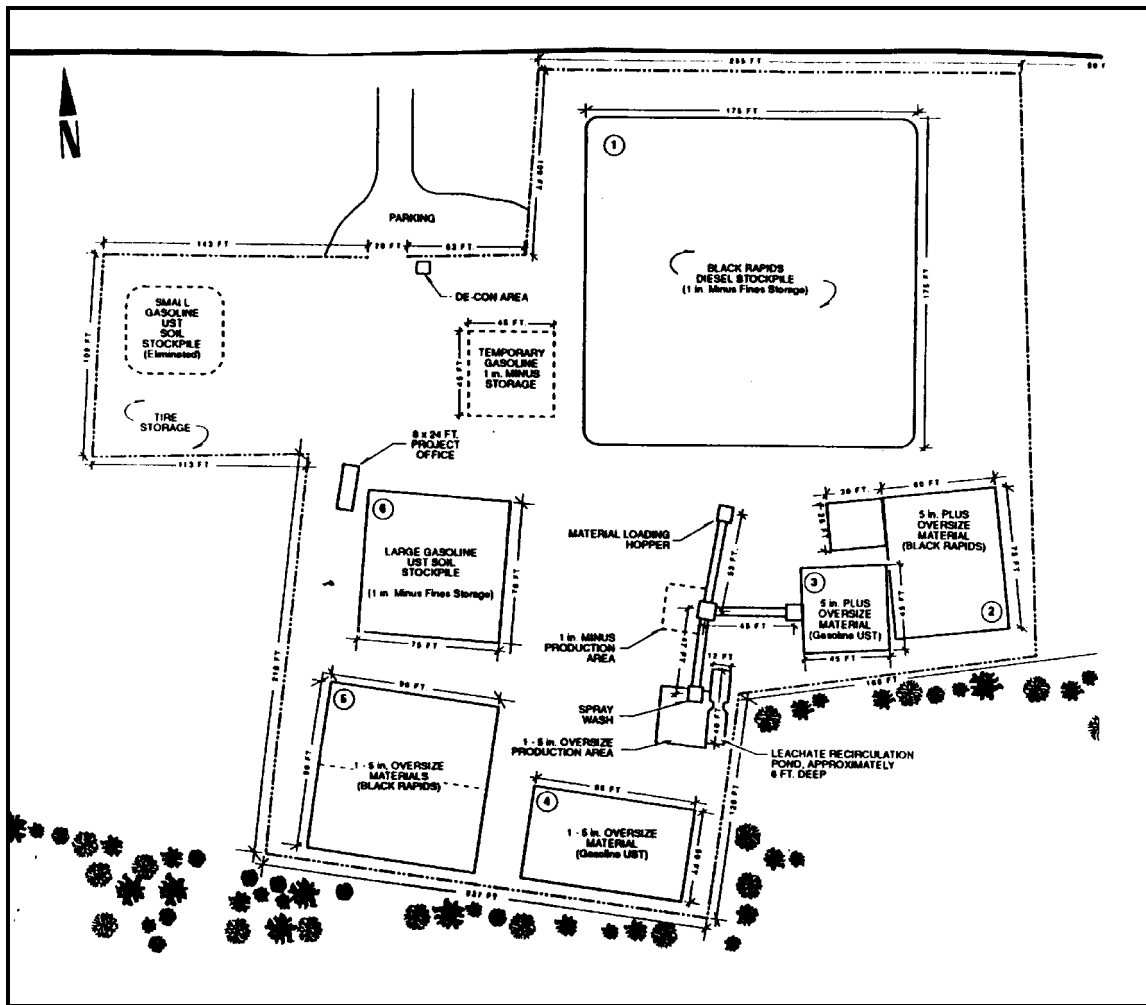


Figure 1. Layout of Screening and Washing Equipment - Phase I (1)

- The following table presents the volume of each of the soil stockpiles screened during Phase I by particle size, along with the volume of soil treated during Phase II.

Material Treated	Phase I	Phase II
	Volume of Screened Stockpiles ¹	Volume of Treated Material ¹
Black Rapids Stockpiles - Diesel-Contaminated Soil		
1" minus	5,988 yd ³	5,988 yd ³
1" - 5" oversize	2,090 yd ³	—
5" plus	698 yd ³	—



Material Treated	Phase I	Phase II
	Volume of Screened Stockpiles ¹	Volume of Treated Material ¹
Small and Large Stockpiles - Gasoline-Contaminated Soil		
1" minus	2,462 yd ³	2,462 yd ³
1" - 5" oversize	639 yd ³	—
5" plus	62 yd ³	—
Liner cover over stockpile liner (Estimated one-foot thick layer)		1,350 yd ³
Totals	11,939 yd ³	9,800 yd ³

Note: ¹ Soil volumes based on measurements of stockpiles provided by Delta Survey Associates (1)

- A biotreatability analysis was performed on the one-inch minus soil segregated from the BRS, SGS, and LGS stockpiles and two background samples from the Black Rapids Ski Area soil. The average results are presented under the heading Matrix Characteristics Affecting Treatment Cost or Performance.
- In 1993 and 1994, hydrocarbon analyses were performed on samples from the BRS, SGS, and LGS soils. Samples were analyzed for gasoline range organics (GRO); diesel range organics (DRO); residual range organics (RRO); and benzene, toluene, ethylbenzene and xylene (BTEX). The results of those analyses are presented below by ranges of concentrations and average concentrations.

Soil	Date	Number of Samples	GRO (mg/kg) ¹ Range/ Average ⁵	DRO (mg/kg) ² Range/ Average ⁵	RRO (mg/kg) ³ Range/ Average ⁵	BTEX (mg/kg) ⁴ Range/ Average ⁵
BRS (1" minus)	10/94	5	ND(5) - 13/ 8.2	243-530/ 425	495 - 839/ 670	ND(0.025) - 0.34/0.23
BRS (1" - 2")	10/94	4	ND(5) - 7/ 5.5	ND(10) - 279/138	ND(40) - 58/ 45	ND(0.025) - 0.30/0.088
SGS/LGS (1" minus)	10/94	2	ND(5) - 84/ 44.5	162 - 1200/ 681.0	215 - 1420/ 818	ND(0.2) - 2.36/1.28
SGS/LGS (1" - 2")	10/94	2	—/ND(5)	15 - 44/30	118 - 362/ 240	—/ND(0.2)
SGS/LGS (before screening)	6/93	29	ND(1) - 3000/372			ND - 20.2 ⁶



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Notes:

ND() Not detected in concentrations above the reported detection limit. The detection limit (shown in parentheses) was used in calculating averages for samples for which results were ND.

¹ GRO by U.S. Environmental Protection Agency (EPA) Method 5030/8015 Modified

² DRO by EPA Method 3540/8100 Modified

³ RRO analyzed as Total Petroleum Hydrocarbons (TPH) by EPA Method 418.1

⁴ BTEX by EPA Method 8020

⁵ Average concentration for all reported results. The higher of the results from any duplicate samples was used to calculate this average.

⁶ Calculation of the average concentration of BTEX was not possible because of high detection limits reported for several of the samples.

Phase II - Land Treatment (1, 2, 5)

- Soil at the Landfill 7 area totaling approximately 22,000 yd³ was graded to accommodate the land treatment operations, and a stormwater control berm, a containment ditch, and a collection area were constructed to control stormwater runoff and runoff.
- As described above, only soils from the BRS, SGS, and LGS stockpiles that had a particle size of one inch or less were included in the land treatment application. With a front-end loader, a dumptruck, and a dozer, the soil was placed on the graded area in uncompacted five-foot-high windrows (35 for the diesel contaminated soil and 8 for the gasoline contaminated soil). The rows were set approximately 20 feet apart. Figure 2 shows the configuration of the windrows.
- According to the ADEC, the contractor had designed the configuration of the windrows to allow the most efficient use of the tilling machine, to keep the GRO and the DRO soils separate, and to fit the configuration of the site.



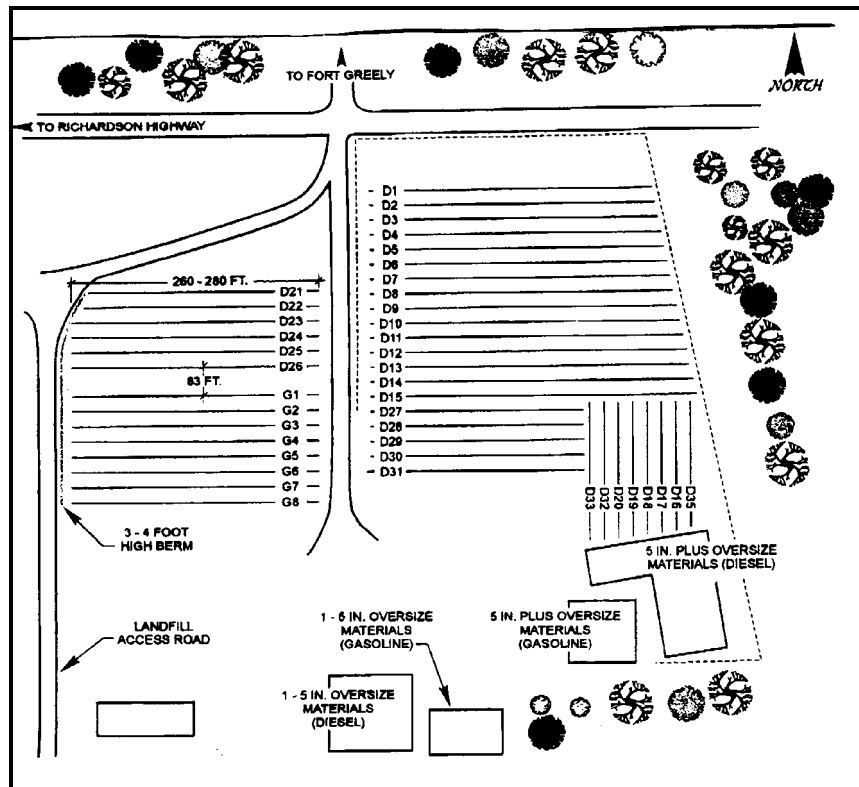


Figure 2. Layout of Windrows for Land Treatment Process: Phase II (2)

- With a scat rotary mixer-tiller, each windrow was tilled from bottom to top once each week during the summers of 1995 and 1996 (July through September in 1995 and June through August in 1996).
- The site work was conducted under a site-specific safety and health plan. The tilling machine was towed with a bobcat that had roll protection, and the operator wore a hard hat, steel-toed boots, and coveralls. Workers conducting sampling and testing wore level D personal protective equipment, which consisted of Tyvek coveralls, hard hat, protective boots, and Nitrile gloves.

OPERATING PARAMETERS AFFECTING TREATMENT COST OR PERFORMANCE (1, 2)

Parameter	Value
Mixing Rate/Frequency	Tilled weekly during the summers of 1995 and 1996 (July through September 1995 and June through August 1996)
Moisture Content	8 - 13% (soil dry weight)
pH	7.3 (average) initially
Residence Time	2 years (July 1995 - June 1997)
Temperature	52.5° F (mean summer)
Microbial Activity:	
- Oxygen Uptake Rate	17.4 mg O ₂ /kg soil/day
- CO ₂ Evolution	Information not provided
- Hydrocarbon Degradation	5.0 mg hydrocarbon/kg soil/day
Nutrients and Other Amendments	Information not provided



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TREATMENT SYSTEM PERFORMANCE

PERFORMANCE OBJECTIVES (1,2,5)

- The goal of this remedial action was to meet the ADEC Level A standards for UST-contaminated soils (as cited at 18 AAC 78.315) so that the soil could be used as final cover material for Landfill 7. The Level A standards are:

Parameter	Cleanup Level
DRO	100 mg/kg
GRO	50 mg/kg
Benzene	0.1 mg/kg
Total BTEX	10 mg/kg
RRO	2,000 mg/kg

TREATMENT PERFORMANCE DATA (2)

- Soil in the windrows was sampled in September 1995, August 1996, and June 1997. The frequency and analysis parameters presented below were used for the soil sampling.

Location	Date	Frequency	Parameters
Windrows of Gasoline-Contaminated Soil	September 1995, August 1996	<ul style="list-style-type: none"> - Two Samples for initial 100 yd³ - One sample for each additional 100 yd³ - Total of 30 samples per year 	DRO, GRO, BTEX
	June 1997	<ul style="list-style-type: none"> - Two samples for initial 50 yd³ - One sample for each additional 50 yd³ - Total of 51 samples (plus 5 duplicates and 5 quality assurance/quality control QA/QC samples) 	
Windrows of Diesel-Contaminated Soil	September 1995, August 1996	<ul style="list-style-type: none"> - Two samples for initial 100 yd³ - One sample for each additional 300 yd³ - Total of 26 samples per year 	DRO
	June 1997	<ul style="list-style-type: none"> - Two samples for initial 50 yd³ - One sample for each additional 150 yd³ - Total of 42 samples (plus 5 duplicates and 5 QA samples) 	
Beneath Liner of BRS	September 1995	- 31 samples from 30,625 ft ² (plus 6 QA/QC samples)	DRO
Beneath Liner of SGS	September 1995	- Two samples from 2,025 ft ² area (plus 2 QA/QC samples)	DRO, GRO, BTEX
Beneath Liner of LGS	September 1995	- Six samples from 5,700 ft ² area (plus 2 QA/QC samples)	DRO, GRO, BTEX



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- The results of the soil sampling in relation to ADEC's Level A cleanup standards are presented in the following table. Because concentrations of RRO in untreated soils were below the cleanup standard, no analyses of RRO were performed. Benzene was not reported separately from BTEX.

Location	Date	Number of Samples	DRO		GRO		BTEX	
			Mean Conc. (mg/kg)	Number of Samples Exceeding Cleanup Standards	Mean Conc. (mg/kg)	Number of Samples Exceeding Cleanup Standards	Mean Conc. (mg/kg)	Number of Samples Exceeding Cleanup Standards
ADEC Level A Standards			100		50		10	
Gasoline-Contaminated Windrows	9/95	25	263	25	ND - 5	0	ND	0
	8/96	25	77	5	NS	NA	NS	NA
	6/97	51	71	1 (115 mg/kg)	ND	0	ND	0
Location	Date	Number of Samples	DRO		GRO		BTEX	
			Mean Conc. (mg/kg)	Number of Samples Exceeding Cleanup Standards	Mean Conc. (mg/kg)	Number of Samples Exceeding Cleanup Standards	Mean Conc. (mg/kg)	Number of Samples Exceeding Cleanup Standards
Diesel-Contaminated Windrows	9/95	21	279	21	NS	NA	NS	NA
	8/96	21	93	8	NS	NA	NS	NA
	6/97	42	80	1 (140 mg/kg)	NS	NA	NS	NA
SGS/LGS Liner Areas	9/95	8	ND - 23	0	ND	0	ND	0
BRS Liner Areas	9/95	31	ND - 68	0	NS	NA	NS	NA

Notes:

ND - Not detected in concentrations above method detection limits

NS - Sample not analyzed for parameter

NA - Not applicable

- The final RAR for the site was completed in May 1998. The RAR was submitted to the ADEC, which concurred that the soil met cleanup objectives.



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PERFORMANCE DATA ASSESSMENT

- Only the soil in the gasoline-contaminated windrows was analyzed for GRO and BTEX. The results of the analysis of samples collected in the September 1995 sampling showed that the concentrations of GRO and BTEX were below the cleanup standards in all 25 of the windrows sampled. Concentrations of GRO ranged from not detected to 5 mg/kg. BTEX was not detected.
- The soil in both the gasoline- and the diesel-contaminated windrows was analyzed for DRO. The results of the analysis of samples collected in June 1997 showed that concentrations of DRO were below the cleanup standard in all but one sample of each type of contaminated soil. The concentrations of DRO that exceeded the cleanup standard were 115 mg/kg for the gasoline-contaminated windrows and 140 mg/kg for the diesel-contaminated windrows. According to the USACE, those exceedances were statistically insignificant. (5)
- On the basis of the average concentrations of DRO and GRO in pretreatment (1994) and post-treatment (1997) soil, the mass of DRO in the soil was reduced from 4,641 to 719 kg, and the mass of GRO in the soil was reduced from 174 kg to nondetectable concentrations. The amounts of DRO and GRO destroyed during the land treatment phase of the remedial action are summarized as follows:

Source	Volume Treated (yd ³)	Average DRO (mg/kg)		Average GRO (mg/kg)		Contaminant Destroyed (kg)	
		1994 ¹	1997 ²	1994 ¹	1997 ²	DRO	GRO
BRS Soil	5,988	424.6	80	8.2	ND ⁵	2,270	54
SGS/LGS Soil	2,462	681.0	71	44.5	ND ⁵	1,652	121
Liner Cover Soil	1,350	0 ⁴	0 ⁴	0 ⁴	0 ⁴	0	0
Total	9,800	—	—	—	—	3,922	175

Notes:

- ¹ 1994 data from (1)
 - ² 1997 data from (2)
 - ³ Average soil density (1,100 kg/yd³) based on average soil dry bulk density of 1.35 grams per cubic centimeter (g/cm³) and water content of 8.6 percent (1)
 - ⁴ Liner cover soil assumed to contain no contamination for purpose of material balance
 - ⁵ All 1997 GRO analyses showed no detection; 0 mg/kg was used for this material balance
- Insufficient analytical data from the period before Phase I were available to determine the amount of contaminant destroyed in Phase I. The contractor estimated that at least 20 percent of the initial GRO volatilized during the soil screening process.



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PERFORMANCE DATA QUALITY (2)

- QA/QC activities were conducted in accordance with specifications, requirements established in contract documents, and guidelines provided by the ADEC.
- Sampling was performed in accordance with the Sampling and Analysis Plan developed for this project in August, 1995, and approved by the USACE and the ADEC.
- QC samples were analyzed by the primary laboratory, and additional QA samples were sent to USACE QA laboratories, which provided the required 1997 government quality assurance report.
- The USACE chemical data quality report concluded that "...the data were sufficiently consistent and results were adequate to satisfy cleanup goals."

TREATMENT SYSTEM COST

PROCUREMENT PROCESS (5)

Procurement for this application was by indefinite delivery-type remedial action (IDTRA) contract. For this contract, only 8A contractors were evaluated. USACE solicited proposals for the contract, and the contractor was selected on the basis of technical qualifications to perform a variety of potential remedial actions. This application was issued as a delivery order against the contract; the contractor submitted a cost proposal for the work; and a firm, fixed price for the application was negotiated.

TREATMENT SYSTEM COST (4)

- The total cost of the Phase I and Phase II work was \$696,171, broken down as follows.

Mobilization and preparatory work	\$76,265
Site Work (Phase I screen and wash)	\$329,618
Land treatment (Phase II)	\$290,288
TOTAL	<u>\$696,171</u>

REGULATORY/INSTITUTIONAL ISSUES

- This remedial action was conducted according to procedures set forth in ADEC's *Guidance Manual for Underground Storage Tank Regulations*, dated June 18, 1991 and in accordance with 18 AAC 78, UST regulations.



OBSERVATIONS AND LESSONS LEARNED

COST OBSERVATIONS AND LESSONS LEARNED

- The total cost of this remedial action was \$696,171, consisting of \$405,883 for Phase I, screening and washing (including site preparation and mobilization) and \$290,288 for Phase II, land treatment.
- A total of 11,939 yd³ of gasoline- and diesel-contaminated soil was processed in Phase I, and 9,800 yd³ (82 percent of the total volume) were treated in Phase II. The unit cost breakdown is:

Phase I ¹	\$34.00/yd ³
Phase II ²	\$29.62/yd ³
Total (w/ 82% of total volume being Land Treated) ³	\$58.29/yd ³

Notes:

- Phase I unit cost for screening and washing of 11,939 yd³ of stockpiled soil
- Phase II unit cost for land treatment of 9,800 yd³ of screened soil (one inch or less in diameter)
- The total unit cost is the average cost of treatment of any given yd³ of originally stockpiled soil (all of which was screened and washed and 82 percent of which was land treated).

PERFORMANCE OBSERVATIONS AND LESSONS LEARNED

- The average concentrations of contaminants indicate that the mass of DRO in the contaminated soil was reduced from 4,641 kg to 719 kg (approximately 85 percent), and the mass of GRO in the contaminated soil was reduced from 175 kg to nondetectable levels (approximately 100 percent) during Phase II (land treatment).
- Initial estimates, based on oxygen uptake measurements taken during the treatability study, showed that remediation of the soil would take approximately 60 days of summer temperatures. The actual remediation took more than twice that long (July 1995 through July 1997). That fact suggests that the rates of degradation of hydrocarbons for land treatment estimated from oxygen uptake analyses may require additional adjustment for site conditions, such as the noncontaminant organic composition of the soil or for maintenance factors for land treatment such as addition of nutrients.
- The concentrations of hydrocarbons in the contaminated soil from the SGS, LGS, and BRS stockpiles were reduced to levels below the ADEC Level A standards in two summers (with the exception of one sample each from the gasoline-contaminated windrows and the diesel-contaminated windrows that still contained DRO in concentrations above the cleanup standard). The treated soil was used in the capping of the landfill.
- The contractor concluded that use of PES-31 during the soil washing in Phase I was probably not necessary, but that the analytical scope of the analyses should have been increased to determine whether such was the case.



REFERENCES

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